NOAA SECTORAL APPLICATIONS RESEARCH PROGRAM (SARP)
PROJECT ANNUAL REPORT

PROJECT TITLE

Estimating the impacts of complex climatic events: the economic costs of drought in Colorado, Nebraska and New Mexico

INVESTIGATORS
(Research team and full contact information)

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PROJECT YEARS **3**

TIME PERIOD ADDRESSED BY REPORT *(e.g., August 2002-March 2003)*

April 2008 – March 2009

I. PRELIMINARY MATERIALS

This study focuses on the economic losses associated with drought. Drought occurs every year across different regions of the United States. The amount usually quoted for annual average economic losses in the United States due to drought is $6-8 billion (FEMA 1995). This number likely underestimates the actual impact of drought and certainly is not representative of the last ten years. Economic estimates of the impacts of past droughts have been difficult to produce and are likely to be either significantly higher or lower for any given year than the FEMA estimate. Drought is also possibly the only natural hazard in which the secondary impacts may be greater than the primary impacts because of the way they filter through the economy. Few or no official loss estimates exist for the energy, recreation/tourism, forestry, and environmental sectors. As the momentum for implementing mitigation strategies to reduce future drought impacts increases, it is evident that the United States needs a concerted effort to quantify the economic impacts of drought in order to understand the monetary benefits of these proactive risk mitigation strategies.

A Project Abstract *(Limit to one page)*

B Objective of Research Project *(Limit to one paragraph)*

The study will be developed as follows: (1) Determine the geographical level of the analysis (Colorado, New Mexico, Nebraska, and Wyoming) and the level of detail (e.g., local business and tax impacts versus broad categories like agriculture, manufacturing, recreation, etc.), which affects the way one interprets the input-output coefficients of the localized IMPLAN model (there may be no substitutes for an agricultural input creating large multiplier effects locally, but statewide there may be plenty of alternative sources of supply, so statewide multiplier effects in some cases may prove to be less important). (2) Identify and characterize significant droughts over the past ten years *(Hayes, Pulwarty)*. (3) Carry out interviews and surveys with key state agency and industry personnel on specific direct impacts of past droughts and impacts-reporting criteria for water tourism, agriculture, and wildfires *(Pulwarty, Hayes, Howe)*. (4) Identify and measure directly imposed economic damages (e.g., direct losses of value added in agriculture and damage to agricultural capital assets including tree crops). This will also include looking at issues such as how payments from federal crop insurance reduce damages as seen from a state viewpoint but not from a national viewpoint *(Supalla, Howe, Ding)*. (5) Identify and measure indirect damages in sectors linked to agriculture, energy and tourism. Lost value-added income in sectors linked to agriculture, for example, can be counted for short-run impacts *(Team)*.

The investigators will begin by examining recent droughts and the sectors affected in Nebraska, Colorado, and New Mexico, with an emphasis on the 2002 drought. This was one of the driest years for each of the three states over the past 100 years. This drought was embedded in the longer-term dry period that extended from 1999-2004. From this, a list of sectors particularly vulnerable to droughts will be developed for each state. Information about the economic impacts will be based from available data, as well as information obtained from telephone surveys and semi-structured interviews to be conducted with state-level department personnel in the Tourism, Agriculture, Natural Resources and Water sectors. In some cases, information will also be collected and assimilated from state-level representatives of some of the federal agencies as well, particularly within USDA. The project will begin to understand direct and indirect losses and work to identify and understand various economic loss estimation techniques available, with the hope of encouraging a standardization of estimates so that official can begin to compare "apples to apples", and be able to make decisions based on these estimates. Finally, the investigators would like to identify and/or develop methodologies that could be used by officials in order to estimate drought losses in various locations, sectors, and geographic scales around the country.

The investigators anticipate a variety of results and benefits for both the public and the scientific community as a result of this project. First, this study will provide the opportunity to begin to answer some very specific questions related to drought impacts on individual sectors that have rarely been addressed such as the energy, timber, and recreation and tourism industries, and others. Second, this project will encourage the development of standardized methodologies for estimating economic losses from droughts at national, regional, state, and local scales. It will also assist in developing standard methods for identifying, collecting, and quantifying drought impacts at these scales as well. Third, this project will be a step toward the development of national and regional assessments of drought conditions across the United States. Finally, this project supports both the National Integrated Drought Information System (NIDIS) and the proposed National Drought Preparedness Act (2005). Both of these national initiatives call for better drought impact assessment methodologies in order to improve drought mitigation and response actions in the United States. Mitigation and preparedness are the keys

C Approach (including methodological framework, models used, theory developed and tested, project monitoring and evaluation criteria) include a description of the key beneficiaries of the anticipated findings of this project (e.g., decision makers in a particular sector/level of government, researchers, private sector, science and resource management agencies) *(Limit to one page)*

D Description of any matching funds/activities used in this project *(Limit to one paragraph)*

The National Drought Mitigation Center also has complementary funding through a grant provided by the USDA's Risk Management Agency (RMA). This RMA funding supports Ya Ding's salary, as well as a subcontract to the University of New Mexico that supports Janie Chermak there.

II. ACCOMPLISHMENTS

A. Brief discussion of project timeline and tasks accomplished. Include a discussion of data collected, models developed or augmented, fieldwork undertaken, or analysis and/or evaluation undertaken, workshops held, training or other capacity building activities implemented. *(This can be submitted in bullet form – limit to two pages)*

Accomplishments during the second, third, and fourth quarters of 2008 (April-December):

- The NDMC had two meetings with officials from Hawaii on June 23 in Wailea, Maui and June 27 in Waikoloa to discuss economic assessment methodologies and estimates for Hawaii. Lessons learned from this project were valuable in what was discussed during these meetings.
- Ya Ding attended the Western Agricultural Economics Association annual meeting in Big Sky, MT, June 26-28, and presented the study "Climate Risks and the Adoption of Conservation Tillage Systems: An Application of Growth Mixture Model".
- Ya Ding had discussions on economic assessment strategies with visitors to the NDMC from Saudi Arabia, Portugal, Spain, and India (April 21, May 1, May 9, and June 10, respectively).
- The NDMC continues to interact with North Carolina and staff at the National Climate Data Center in Asheville, NC, on economic assessment methodologies and estimates.
- Ya Ding updated the literature of drought economic impacts, focusing on the impacts of municipal drought on public water supply.
- Janie Chermak and Jee Hwang at the University of New Mexico in Albuquerque completed a major revision during the Quarter of their research paper, titled "44 Years of New Mexico Pecans and Drought". They also continue to investigate the impact of drought on the dairy industry in New Mexico.
- Ya Ding and Michael Hayes prepared a white paper entitled "Measuring economic impacts of drought: a review and discussion". This paper has been distributed to NDMC faculty and staff to collect comments.
- County-level disaster payment data have been collected and compiled for Nebraska.
- Prabhakar Shrestha defended his Masters Degree thesis on the drought impacts on rafting activities in Colorado in December. A short summary of his work, published in

Cornhusker Economics, available at http://www.agecon.unl.edu/Cornhuskereconomics/2008/4-23-08.pdf.

Accomplishments during the first quarter of 2009 (January-March):

- Ya Ding, Karina Schoengold and Tsegaye Tadesse have revised and resubmitted the article "The Impact of Weather Extremes on Agricultural Production Methods" to the *Journal of Agricultural and Resource Economics*.
- Michael Hayes, Ya Ding, and Melissa Widhalm reviewed and provided comments to Janie Chermak and Jee Hwang on their research paper "44 Years of New Mexico Pecan and Drought".
- Ya Ding updated the database of RMA crop indemnity losses from 1989 through 2008, including information on indemnity losses due to drought impacts.
- Ya Ding, Melissa Widhalm, and Mike Hayes have nearly completed the revisions for a journal article titled "Measuring economic impacts of drought: a review and discussion."
- Ya Ding, Melissa Widhalm, and Mike Hayes have been holding quasi-weekly meetings throughout the spring months.
- The dialogue on the economic impacts of drought continued during the spring with a small group of scientists at the National Climatic Data Center (NCDC) in Asheville, NC. NCDC publishes the most "official" economic impacts of natural hazards, and is very interested in the economic impact assessment methodologies-aspect of this project [http://www.ncdc.noaa.gov/oa/reports/billionz.html].
- Ya Ding continues to work on the investigation of conservative farming practices and the impact climate has on these practices by agricultural producers.

B. Summary of findings, including their potential or actual implications for efforts to develop applications, methods, and science-based decision support capacity/systems and to foster sustainable resource management and vulnerability reduction. *(Limit to two pages)*

During the past year, the investigators focused their attentions on several sector-specific studies. In New Mexico, Chermak and Hwang are nearly completed with their study on the pecan industry. This work will be submitted to a scientific journal when completed, and will highlight drought impacts on the pecan industry for future decision making opportunities. Prabhakar Shrestha, a graduate student at the University of Nebraska-Lincoln, is nearing completion of his research on the economic impacts of drought on the rafting industry along the Arkansas River in Colorado. Mr. Shrestha defended his thesis in December 2008, and is now finishing the revisions on his thesis. Work being led by Ya Ding is looking at the economic impact of irrigation decisions across the region, although the focus is mainly on Nebraska.

Each of these three studies, and additional work being done as part of the project, has identified several important lessons learned that can contribute to methodological discussions on determining the economic impacts of drought. First, comprehensive statewide economic estimates are very difficult to determine based on a variety of factors, including drought characteristics, regional effects, economic conditions, etc. Second, drought needs to be defined by sector and location, and this should be at a smaller scale than the state level. Third, direct and indirect effects of drought are determined differently.

Based on these lessons, discussions have begun with researchers at New Mexico State University regarding a river basin approach to determining economic impacts from drought. In a paper by Ward et al. (2006), a similar approach was completed for the Rio Grande Basin in Colorado, New Mexico, and Texas. As mentioned above, although the location and conditions of the Rio Grande Basin are unique, the methodology developed can be applied elsewhere. This approach is promising. Results showed that potential economic impacts to New Mexico agriculture, for example, were $6 million above Elephant Butte Reservoir and $10 million below the reservoir per year during a drought. These results could help decision makers plan ahead and target mitigation strategies to reduce these losses before future droughts. The full reference of this article is: *Ward, F. A., B. H. Hurd, T. Rahmani, and N. Gollehon, 2006. Economic impacts of federal policy responses to drought in the Rio Grande Basin.* ***Water Resources Research****, 42, W03420, doi:10.1029/2005WR004427.*

Discussions continued during the year with officials in various states regarding economic impact estimation. These states include Hawaii, North Carolina, Colorado, and Arizona. As a result of discussions, more formal interactions took place with Hawaii and meetings were held in the state in June 2008 (as part of other activities). Hawaii officials are very interested in this project, and will be working with the NDMC to help establish a methodology for determining economic impacts across Hawaii. In all of the cases, state officials recognize a need for better awareness of economic impacts caused by droughts and a better collection system of economic impacts at a state level.

In an effort to accommodate the needs of state officials expressed above, the revision process of the NDMC's Drought Impact Reporter tool will include a much better system for economic impacts to be collected, recorded, and archived within the tool. This will be part of the national function of the tool, but there will also be a more state-specific functionality of the tool. Accomplishing this will improve the overall abilities to estimate economic impacts at local, regional, and state levels.

During 2008, the main regions of drought hit California, Texas, and the southeastern United States hardest. Investigators collected and archived economic impacts during the year using the NDMC's Drought Impact Reporter tool [http://droughtreporter.unl.edu/]. Impacts were reported in the following sectors: grain production, citrus production, livestock production, nursery crops and landscape services, recreation and tourism, public utilities, and residential water use.

Another aspect of this project was to review drought conditions for the three states (Colorado, New Mexico, and Nebraska). Because of enhancements made to the U.S. Drought Monitor tool, historical time series of the U.S. Drought Monitor map for the three states were produced. These time series are included as a Power Point slide as part of this annual report. For Colorado, the slide shows that clearly 2002 was the peak of the drought in that state, but that drought lingered until early 2005 and then made a return in 2006. New Mexico had several prominent spikes of drought during 2002, 2003-2004, and 2006. Nebraska also had drought during 2002-2004 and in 2006. The time series show that there are definite similarities and differences between the three states. Related to the lessons learned stated above, the specific economic impacts caused by these droughts are going to be sector, location, and timing dependent.

C. List of any reports, papers, publications or presentations arising from this project; please send any reprints of journal articles as they appear in the literature. Indicate whether a paper is formally reviewed and published. *(No text limit)*

1. Ya Ding revised a white paper titled "Measuring Economic Impacts of Drought: A Review and Discussion."

2. Based on this white paper, Ya Ding, Michael Hayes, and Melissa Widhalm have developed a journal article titled "Measuring Economic Impacts of Drought: A Review and Discussion."

3. Janie Chermak and Jee Hwang have developed a draft journal article on the impacts of drought on the Pecan Industry in New Mexico titled "44 Years of New Mexico Pecans and Drought."

4. Ya Ding presented a talk titled "Climate Risks and the Adoption of Conservation Tillage Systems: An Application of Growth Mixture Model" at the Western Agricultural Economics Association annual meeting in Big Sky, MT, June 26-28.

D. Discussion of any significant deviations from proposed workplan (e.g., shift in priorities following consultation with program manager, delayed fieldwork due to late arrival of funds, obstacles encountered during the course of the project that have impacted outcome delivery). *(Limit to one paragraph)*

A no cost extension has been requested for this project through June 2010. Substantial progress has been made toward accomplishing the objectives of the project, but there are still tasks to be completed. Tasks focused within Nebraska, Colorado, and New Mexico have been completed. What remains includes putting these efforts into a more general methodology and lessons learned that can be adopted elsewhere. One reason for the delay is that both Mike Hayes and Roger Pulwarty had major job changes after the award, and this has slowed the progress of the project. The project now has some important momentum and an extension would help significantly in completing the project and finishing the results that benefit the drought and climate communities.

E. Where appropriate, describe the climate information products and forecasts considered in your project (both NOAA and non-NOAA); identify any specific feedback on the NOAA products that might be helpful for improvement. (bulleted response)

The weekly U.S. Drought Monitor product has been valuable in assessments of drought conditions across Nebraska, Colorado, and New Mexico. This product is jointly produced by NOAA Climate Prediction Center and National Climatic Data Center, USDA, and the National Drought Mitigation Center.

III. GRAPHICS: PLEASE INCLUDE THE FOLLOWING GRAPHICS AS ATTACHMENTS TO YOUR REPORT

A. One Power point slide depicting the overall project framework/approach/results to date

B. If appropriate, additional graphic(s) or presentation(s) depicting any key research results thus far

C. Photographs (if easy to obtain) from fieldwork to depict study information (if applicable).

IV. WEBSITE ADDRESS FOR FURTHER INFORMATION (IF APPLICABLE)

V. ADDITIONAL RELEVANT INFORMATION NOT COVERED UNDER THE ABOVE CATEGORIES.